Artificial Intelligence – Exercise Questions (Propositional Logic)

1. Use truth tables to determine which of the following are equivalent to each other:
   (a)$(P \wedge Q) \vee (\neg P \wedge \neg Q)$
   (b)$\neg P \vee Q$
   (c)$(P \vee \neg Q) \wedge (Q \vee \neg P)$
   (d)$\neg (P \vee Q)$
   (e)$(Q \wedge P) \vee \neg P$

2. Let p stand for the proposition "I bought a lottery ticket" and q for "I won the jackpot". Express the following as natural English sentences:

   (a)$\neg p$
   (b)$p \vee q$
   (c)$p \wedge q$
   (d)$p \Rightarrow q$
   (e)$\neg p \Rightarrow \neg q$
   (f)$\neg p \vee (p \wedge q)$

3. For each of the following propositions, construct a truth table and state whether the proposition is valid or satisfiable. (For brevity, you can just write one truth table with many columns.)
   (a)$p \wedge \neg p$
   (b)$p \vee \neg p$
   (c)$(p \vee \neg q) \Rightarrow q$
   (d)$(p \vee q) \Rightarrow (p \wedge q)$
   (e)$(p \Rightarrow q) \Leftrightarrow (\neg q \Rightarrow \neg p)$
   (f)$(p \Rightarrow q) \Rightarrow (q \Rightarrow p)$

4. For each of the following propositions, construct a truth table and state whether the proposition is valid or satisfiable.
   (a)$p \Rightarrow (\neg q \vee r)$
   (b)$\neg p \Rightarrow (q \Rightarrow r)$
   (c)$(p \Rightarrow q) \vee (\neg p \Rightarrow r)$
   (d)$(p \Rightarrow q) \wedge (\neg p \Rightarrow r)$
   (e)$(p \Leftrightarrow q) \vee (\neg q \Leftrightarrow r)$
   (f)$(\neg p \Leftrightarrow \neg q) \Leftrightarrow (q \Leftrightarrow r)$

5. Use truth tables to determine which of the following are equivalent to each other:

   (a)P

   (b)$\neg P$

   (c)$P \Rightarrow F$

(d)$P \Rightarrow T$

(e)$F \Rightarrow P$

(f)$T \Rightarrow P$

(g)$\neg\neg P$